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## Precast Hybrid Moment Resistant Frames

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## PRECAST HYBRID MOMENT RESISTANT FRAMES

### THE NEED

The recent disasters from earthquakes in Northridge, California and Kobe, Japan, demands a structural design that will provide integrity of the structure and protection of the investment against seismic activity. Charles Pankow builders developed a new frame that absorbs seismic energy independent of the integrity of the structural members and that delivers superior post elastic response.



FIGURE 1 CURRENT CONCRETE TECHNOLOGY AFTER A 3% STORY DRIFT

### THE TECHNOLOGY

The Precast Hybrid Moment Resisting Frame (PHMRF) involves a column/beam connection utilizing both elastic and inelastic action at the joint for Precast Moment Resistant Frames. The innovative joint and the changed design concepts it represents involve a paradigm shift away from designs that require structures to absorb seismic energy through inelastic response of the framing members.

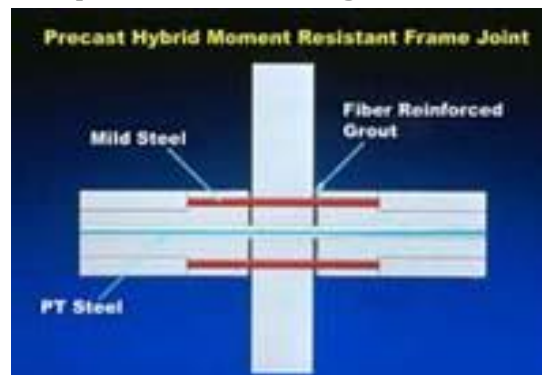


FIGURE 2 JOINT WITH AN HYBRID OF ELASTIC AND INELASTIC ACTION



The post-elastic performance is concentrated in the connection rather than a structural member. The connection's strength component (270k strand) functions within its elastic range and the connection's energy absorbing elements functions inelastically. This moment frame, which simultaneously combines both inelastic and elastic responses, shows minimal damage consisting of minor spalling when tested to a rotation equivalent story drift of 4 %. The concept would isolate and separate the strength and energy absorption components within the joint. High strength post-tensioned steel would give the joint its strength to resist the applied dead, live and seismic loads. Mild steel would be utilized across the joint to serve as an energy dissipater by yielding under seismic loading.



**FIGURE 3 PHMRF JOINT AFTER A 4% STORY DRIFT**

## THE BENEFITS

- Following an earthquake, a structure with these frames will require only normal inspection and minimal, if any, repair to the structural members.
- The value of the structure is less likely to diminish after a seismic event.
- The connection system also allows a faster project delivery time. Its application in a real project delivered time savings close to 45% when compared with other Type 1 structures.
- Due to the system's simplicity and constructability when it was applied to a real project it provided savings of over 60% in the number of man-hours necessary to construct a conventional lateral bracing system.
- Provides a major increase in safety in seismic regions. Providing not only protection to the public but to the owners and lenders investments.

## STATUS

The technology has been tested by the National Institute of Standards and Technology (NIST), Building and Fire Research Laboratory. It has already been used in several projects, including the Roosevelt Field Mall expansion, Long Island, New York, a parking structure in Eugene Oregon, at Stanford Shopping Center's new parking structure, Palo Alto, California and is currently being constructed in a Los Angeles office



building and a 40-story apartment high-rise in San Francisco. The ACI American Concrete Institute established an Innovative Task Group to evaluate the technology and draft the required code language changes necessary for accommodation in the Building Code Requirements for Reinforced Concrete (ACI 318).



**FIGURE 4 ROOSEVELT FIELD MALL, NEW YORK**

## **POINTS OF CONTACT**

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## **REFERENCES**

1. Charles Pankow Builders, Ltd & The Pankow Consortium. (1996) "Precast Hybrid Moment Resistant Frames - Innovation History From Concept to Technology". Charles Pankow Builders, Ltd. 2476 N. Lake Avenue, Altadena, California 91001.

## **REVIEWERS**

Peer reviewed as an emerging construction technology

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## **PUBLISHER**

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